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Sierra Harris

University of Nebraska-Lincoln

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The Relationship of Two Invasive Wetland Plant Species, Common Reed
(*Phragmites australis*) and Purple Loosestrife (*Lythrum salicaria*), and the
Relative Availability of Sandhill Crane Roosting Habitat on the Central
Platte River

An analysis of quantitative research data

Sierra Harris

ENVR 499B Senior Thesis
Dr. Dave Gosselin and Mrs. Sara Cooper

School of Natural Resources
University of Nebraska Lincoln
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Abstract

This study provides imagery related to the relationship between the invasive plants, common reed and purple loosestrife, and sandhill crane roosting habitat in south-central Nebraska during spring migration. Three time-lapse camera locations are used to support findings from various literature findings. A continued analysis of this relationship is necessary because sandhill cranes are ecologically and economically important to Nebraska. Various habitats along the central Platte River are critical staging habitats, which influence sandhill crane survival while they migrate north to breeding grounds. Common reed and purple loosestrife alter these habitats and have negative impacts on sandhill crane roosting sites, therefore managing and controlling these invasive wetland plant species is necessary.

Introduction

Resources provided by the Platte River and its riparian habitats are the key to a wide range of species' survival. The Platte Rivers have been altered to meet human needs, such as urban development, irrigation, and the introduction of non-native vegetation (Krapu et al., 1984). In 1866, the Platte River channel in Nebraska between Kearney and North Platte was 1,200 to 2,000 meters wide, but has decrease dramatically over time (Krapu et al., 1982). Coincidentally many species that rely on the river's natural processes often run into challenges.

Managing and preserving the central Platte River in south-central Nebraska is crucial for the survival of millions of migratory bird species, including the sandhill crane (Forsberg, 2003). The sandhill crane is not currently listed as an endangered or

threatened species, although important staging habitat used during spring migration continue to dwindle.

Many organizations are known for their conservation efforts along the Platte River to ensure suitable habitats are available and to maintain the natural system as much as possible. Locations such as Rowe Sanctuary protect the river and surrounding habitats to aid the survival of migratory birds, including the sandhill crane. Rowe Sanctuary is owned and managed by the National Audubon Society and is located in the Platte River Valley near Gibbon, Nebraska. It is a great place for people from all over the world to learn about the river and wildlife, including the special experience observing spring migration from blinds along the riverbank. Nature-based education is provided year-round at Rowe Sanctuary, which helps people understand the importance of the Platte River and migration (Audubon Society, 2012). The Nebraska Game and Parks Commission, Crane Trust, the National Audubon Society, the National Wildlife Federation, and many others provide educational information about migratory birds and wildlife on the Platte River online and at various locations.

Tagging methods are used to monitor sandhill crane migration routes. Their legs are tagged and then counted once they reach new locations and ultimately their final destination (Tacha et al., 1984). Known migration routes during the spring and winter can help conservation and management of the habitats used. Located habitats can be managed by analyzing water quality and quantity, food availability, and disturbance whether it is naturally occurring or human influenced (Folk and Tacha, 1990). Aerial infrared photography, remote sensing, and GIS data can also be used to study and map habitats (Folk and Tacha, 1990). For this study, time-lapse imagery is used to observe

the relationship between common reed (Figure 1) and purple loosestrife (Figure 2) presence and the availability of sandhill crane roosting habitat at Audubon's Rowe Sanctuary.

Each spring, between late February and mid-April, sandhill cranes migrate north to breeding grounds in the Canadian Arctic, western Alaska, and northeastern Siberia (Forsberg, 2003). The migration path used to fulfill this long journey is known as the Central Flyway (Figure 3), in which the pinch in its hourglass shape consists of a small section of the Platte River in south-central Nebraska (Krapu et al., 1984).

About 80 percent of the world's population of sandhill cranes stage along this 80-mile stretch of the central Platte, between North Platte and Grand Island (Figure 4), to rest and refuel for up to a month (Forsberg, 2003). Sandhill cranes spend half of their day in croplands, where they forage leftover grain from the previous fall harvest. Leftover grains, primarily corn, provide 80-90 percent of the sandhill crane diet (Figure 5). It is metabolized quickly and builds fat reserves needed for their long journey and survival (Krapu et al., 1984). Sandhill cranes spend the other half of the day in wetlands or prairie grasslands to foraging the other 10-20 percent of their diet (Figure 6). Snails, grubs, earthworms, amphibians, and small reptiles consists of protein and calcium, which are needed to ensure healthy eggshells and chicks at the nest once they arrive at breeding grounds (Forsberg, 2003).

Each night, from dusk to dawn, sandhill cranes gather on the central Platte River to communally rest, also referred to as roost. A suitable and preferred roosting habitat for sandhill cranes is a maximum of fifty meters from riverbanks. A former study observed more sandhill cranes roosting on wide river channels compared to narrow river channels,

so maintaining the central Platte River's width increases roosting site availability (Kessler et al., 2011). It is important sandhill cranes rest throughout the night, so areas surrounded by water are chosen to increase predatory detection (Sparling and Krapu, 1994). Sandhill cranes prefer short vegetation along the riverbank in order to limit predatory risk; therefore tall vegetation along riverbanks can cause unwanted obstruction to available roosting sites (Krapu et al., 1984). When severe weather occurs or when the river channel is unsuitable for roosting, sandhill cranes use wetlands as secondary roosting sites to limit the disturbance (Sparling and Krapu, 1994). If they roost on the river during these times dense roosting will occur (Figure 7, 8).

Invasive wetland plant species, such as common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*) have negative impacts on roosting availability on the central Platte River. These non-native plant species are considered invasive because they narrow the river channel, anchor sandbars, push out native plant species, and create thick monocultures making riparian habitats unsuitable for many migratory birds (Ailstock et al, 2001).

Common reed was introduced from Europe for erosion control, but is now listed as a state designated noxious weed in Nebraska. It can grow up to 20 feet tall and spreads by extensive rhizomes, seed dispersal, and can be inadvertently transported by recreational equipment (Central Platte River, 2013). Purple loosestrife was introduced from Europe as an ornamental and is also a state designated noxious weed in Nebraska. It can grow up to 8 feet tall and is found in marshes, river and creek banks, ditches, and wet meadows. Purple loosestrife can spread by re-sprouting from stem cuttings,

regeneration of root stock pieces, and seed dispersal by wind, water, wildlife, and recreation equipment (Central Platte River, 2013).

Common reed and purple loosestrife are prolific plants that have significant impacts on native species in wetlands and riparian areas (Kessler et al., 2011). In recent years these invasives have been encroaching on riverbanks and anchoring sandbars on the central Platte River causing drastic changes in the river's hydrology and surrounding habitats (Kessler et al., 2011).

When common reed and purple loosestrife start to invade, plant diversity is reduced until an eventual monoculture exists (Kessler et al., 2011). The number of bird species found in invaded riparian areas and wetlands decrease due to the limited plant diversity and alteration of the river's natural processes (Kessler et al., 2011). In explaining the impact of invasives on crane roosting habitat, Kessler et al. (2000) stated, "as the area of common reed expanded to the maximum forecasted distance the area of sandhill crane roosting habitat decreased by 250%".

For many years, wetland managers have observed negative impacts due to the presence of purple loosestrife though little quantitative research has documented its impact on sandhill crane roosting availability (Blossey, et al., 2000). According to Blossey (1999), "encroachment by purple loosestrife is suspected to reduce the available habitat and recruitment of a number of duck species, canada goose, and sandhill cranes." Purple loosestrife has also replaced cattails in many North American wetland habitats. Due to this replacement, changes in decomposition rates and sediment chemistry may have important impacts on the invaded system or to wetlands downstream (Blossey,

1999). If these trends continue, the negative results are substantial for the future of currently available roosting sites.

Land management and control treatments need to be applied annually to decrease common reed and purple loosestrife abundance. Methods that have been conducted in the past, such as applying herbicide or a combination of herbicide and burning have been found to decrease the species' prevalence, but do not eliminate them (Ailstock et al., 2001). The herbicide-burn method had the best results, decreasing common reed by over fifty percent in the study location (Ailstock et al., 2001). Traditional control methods have been used on purple loosestrife in Minnesota, but resulted in only short-term positive outcomes (Blossey et al., 2000). Controlling both common reed and purple loosestrife at one location is difficult; once one of the invasive species decreases, the other thrives. As observed by Blossey et al. (2000), "at several sites, other invasive species such as *Phragmites australis* (common reed) or *Phalaris arundinacea* (reed canary grass) expand as purple loosestrife is controlled, clearly not a desired result". Finding control methods that have long-term results for both common reed and purple loosestrife is difficult, but researchers in North America are analyzing a variety of control methods to find the best results (Blossey et al., 2000).

In this study, time-lapse imagery is used to supplement previous research regarding the relationship between common reed and purple loosestrife and the availability of sandhill crane roosting habitat along the central Platte River. I believe there will be a significant decrease in the number of sandhill cranes in areas with large populations of common reed and purple loosestrife. Sandhill cranes will have less suitable roosting sites due to decreased channel width, amount of water present, and

increased vegetation on sandbars. The image data obtained from time-lapse cameras will be used to analyze channel width, water depth, sandhill crane distribution and abundance, and invasive plant distribution.

Literature Review

Previous studies that discuss sandhill crane habitat characteristics and locations as well as information about common reed and purple loosestrife are used as references regarding the observed relationship on the central Platte River. “Migration Routes of Sandhill Cranes from Mid-Continental North America” by Tacha et al. (1984) describes the migration routes and relationships between wintering, migration staging, and nesting areas of sandhill cranes. This article focuses on the impact of hunting on the subpopulations of the sandhill cranes along the migration routes, but for the purpose of my project I will only use the migratory route data. Krapu et al. (1982) “Sandhill Cranes and the Platte River” provides information about the Platte River, its adjacent habitats, and habitat use by the sandhill crane. This article describes how the riparian habitats along the Platte River have changed over time and identifies causes of ecosystem alterations. It also describes impacts these alterations have on the sandhill crane population, and considers alternatives for maintaining the habitats to increase sandhill cranes survival during spring migration. Though this journal article is slightly out-of-date the information provided is relevant because habitat changes listed can still be identified.

Krapu has conducted many research studies about the Platte River and the sandhill crane migration; the results have furthered knowledge of these research topics tremendously. “Habitat Use by Migrant Sandhill Cranes in Nebraska” by Krapu et al.

(1984) discusses the types and locations of staging areas used by the sandhill crane. The article focuses on staging areas such as cropland, native grassland, and tame hayland that have been used for foraging. It also relates the vegetation changes along the Platte River and channel width to the presence or absence of sandhill cranes in various areas (Krapu et al., 1984). This data is helpful because this project depicts the impact invasive species expansion has on habitat use. Roosting site characteristics such as channel width, water depth, and vicinity to obstructions are analyzed in Folk and Tacha (1984), "Sandhill Crane Roost Site Characteristics in the North Platte River Valley". Folk and Tacha (1984) study the relationship of water characteristics at roosting sites sandhill cranes are observed roosting. Though this article describes roosting characteristics on the North Platte River Valley, the information is compared to the roosting characteristics observed on the central Platte River.

Forsberg et al. (2003), "On Ancient Wings: The Sandhill Cranes of North America" is a detailed book that describes the life and annual journey of sandhill cranes. This book is extremely helpful because provides detailed information about spring migration on the central Platte, which is used for a large amount of background and conservation information in this study. The book uses photography to educate readers about the sandhill crane and uses text to provide details; it is an educational story that is appealing to the eye.

"Communal Roosting and Foraging Behavior of Staging Sandhill Cranes" by Sparling and Krapu (1994) is useful for this project because it describes the relationship between distances of roosting site and foraging sites. It observes behaviors of sandhill crane populations in different roosting habitats and how far they are willing to travel to

gather nutrients at foraging sites. These behaviors are important to note for this study because the distance to foraging locations can be a limited if roosting availability decreases at Audubon's Rowe Sanctuary.

Research regarding common reed characteristics is used to troubleshoot presence and absence at roosting sites previously used by sandhill cranes. "Impacts of Invasive Plants on Sandhill Crane (*Grus canadensis*) Roosting Habitat", by Kessler et al. (2011) discusses a large amount of information crucial to this project because my study sites are included in this research and includes both observed invasive species. This article focuses on the ecological and economic damage of common reed in riparian ecosystems. The data forecasted a spread or contraction of common reed in sandhill crane roosting habitats, stating sandhill crane habitat availability decreases by as much as 250% if the invasive plant expands, but the habitat availability increases by 50% with contraction of the plant. This study provides basic information about the impacts of common reed on the availability of roosting habitats.

"Integrated Management of Common Reed (*Phragmites australis*) along the Platte River in Nebraska" by Rapp et al. (2012) discusses different methods to manage the growth of common reed at a location similar to the study sites used for this project. The article focuses on methods such as herbicide, mowing, and disking, either applied alone or in combination. It states that using a combination of these methods is the most successful to reduce the growth of the invasive plant; disking followed by herbicide and mowing followed by herbicide had the greatest success. These methods relate to this project because they are used along the central Platte to manage common reed and purple loosestrife.

In the journal article, “Common Reed *Phragmites australis*: Control and Effects Upon Biodiversity in Freshwater Nontidal Wetlands” by Ailstock et al. (2001) two control methods were used, herbicide application and herbicide-burning combination. Similar to the study conducted in Nebraska, the best method that reduced the abundance of common reed was the combination of herbicide followed by burning. Blossey (1999), “Before, during and after: the need for long-term monitoring in invasive plant species management” includes control methods for purple loosestrife and common reed and the effectiveness of each method studied. This article is useful to compare control methods of both invasive species. Blossey et al. (2000), “Impact and management of purple loosestrife (*Lythrum salicaria*) in North America”, focuses on the importance of conducting quantitative research of the impact of purple loosestrife in North America since little data had been documented at the time. Control methods for purple loosestrife are described, but results found in this study are short term and allow other invasive plants such as common reed to take over.

The “Central Platte River Invasive Plants: Best Management Field Guide” (2013), includes all listed invasive plant species present in Nebraska, specifically along the Platte River. This field guide is extremely helpful when identifying invasives in Nebraska and how they can be controlled. For each invasive plant, the guide lists: common name, scientific name, description, habitat, location in Nebraska, pathway of introduction and spread, and impacts. The information listed for common reed and purple loosestrife is current and detailed.

Materials and Methods

In this project, data from previous studies conducted along the central Platte River relating to sandhill crane migration habitat use are used to reference observed findings from time-lapse photography. Data from journal articles that discuss the extent common reed and purple loosestrife impact native plant species and habitats are also used as reference. Geospatial Information System (GIS) data were used to compare control methods and land management techniques used on the central Platte at the observed locations. Greg Wingfield, the Director of Conservation at Audubon's Rowe Sanctuary, and Rich Walters, the Outreach Specialist for the Nature Conservancy, provided GIS data of the observed location. The referenced research were conducted in the field using a variety of measuring techniques, but for the purpose of this project, data was gathered using time-lapse photography at Audubon's Rowe Sanctuary. The time-lapse imagery is meant to support or decline the relationships observed in the studied literature.

Data collection took place at two locations along the Big Bend reach of the Platte River on Rowe Sanctuary's land near Gibbon, Nebraska. River channel width, water depth, abundance and distribution of roosting sandhill cranes, and common reed and purple loosestrife presence were studied using time-lapse imagery. A time-lapse camera, "Rowe Tower" (Figure 9), has been recording data of the Platte River's appearance and the sandhill crane spring migration at Rowe Sanctuary since March 2011. The data obtained from this camera was used from March 2011 through August 2013 to show the river at an aerial viewpoint. The channel width and roosting habitat used by sandhill cranes are easily shown from the "Rowe Tower" camera. Common reed and purple loosestrife at the observed location can also be seen from the aerial view. The "Rowe Crane Cam" (Figure 10) camera was installed on the same day as the "Rowe Tower"

camera. The view from this camera is meant to capture close-up images of sandhill cranes roosting on the river from 2011-2013.

A time-lapse camera was installed on February 28, 2013 and captured images through August 2013 (Figure 11). This camera view captures images of common reed and purple loosestrife near sandhill crane roosting habitat. The images collected from this camera were used to analyze plant diversity at the location and to estimate the amount of sandhill cranes roosting in close proximity to the invasive plant species. The final analysis of the relationship is shown in time-lapse videos, which depict changes in river channel width, invasive expansion, and sandhill crane roosting distribution.

Results

*See Figures 12-24 for image results

2011

[2011 Spring Migration](#)

[March 19, 2011](#)

[Purple Loosestrife and Common Reed](#)

2012

[March 20, 2012](#)

[Purple Loosestrife](#)

2013

[2013 Spring Migration](#)

[2013 Spring Migration from Temporary Camera](#)

[Common Reed and Purple Loosestrife](#)

Discussion

The GIS data indicates the river channel was disked from 2004-2008 to clear sandbar vegetation. The river channel was the focus for control from 2004-2008, but from 2009-2013 managing the riverbanks became the priority due to the dominant presence of common reed and purple loosestrife. Segments of the north and south riverbanks and vegetated sandbars at Rowe Sanctuary were sprayed with the herbicide Habitat in the summer of 2009, 2011, and 2013. The herbicide was used to decrease common reed populations. Other areas of the central Platte River were sprayed in 2010, but Rowe Sanctuary was not included because this control method is done in small segments each year. Control methods were most effective when two treatments were used during the same summer season, such as disking-herbicide. A mixture of native grass and forb seeds were dispersed along the north riverbank in 2013 to reestablish native plant species. The results from the 2013 seeding can be observed from the “Rowe Tower” camera over the next few years.

In 2011, water levels were high due to the flood year, but shallow water and bare sandbars were present during spring migration. The first sandhill cranes to arrive roosted primarily along the south bank on sandbars with limited vegetation in close proximity to dead common reed. The closest distance observed was approximately 10 feet away from a small stand of dead common reed. As sandhill crane abundance increased in 2011, roosting also occurred in the middle of the river channel and in close proximity to the north bank upstream from the Rowe Tower camera location. Purple loosestrife rapidly grew along the south bank in the summer of 2011.

Water levels were high with few visible sandbars during the 2012 spring migration. The 2011 flood dispersed purple loosestrife and common reed seeds

downstream, so sandhill cranes were rarely seen roosting in close proximity to purple loosestrife or common reed. When roosting occurred along the south bank, cranes were at least 30 feet away with standing water between the roost site and riverbank for predatory detection. The first sandhill cranes to arrive to the river began their roost on the northern side of the river channel, but as more arrived they began occupying available sites throughout the wide channel. Roosting occurred primarily in the middle of the river channel in shallow water or bare sandbars surrounded by water. They were also observed roosting near the north bank upstream from the Rowe Tower camera location. Vegetation cover increased by the summer of 2012. Purple loosestrife dominated the south bank at Rowe Sanctuary, while common reed populations decreased significantly.

In 2013, water depth fluctuations occurred during spring migration. Shallow water and visible sandbars were present throughout the channel, but were occasionally limited. Sandhill cranes roosting primarily in the middle of the river channel like the previous years. When water was high and sandbars were no longer visible, roosting habitat availability decreased, dense roosting increased, and use of vegetated sandbars on the south bank occurred. The water depth fluctuation impacted roosting habitat availability significantly. When water was high, dense roosting occurred at available roosting sites and when water was low, roosting was dispersed throughout the river channel. Dense roosting is not desirable because it can lead to risk of disease and decrease affective rest for sandhill cranes. Occasional roosting within 30 feet of purple loosestrife and common reed was observed. Sandhill cranes began to roost later in the evening and stayed longer in the morning when water was high and during severe weather events. Vegetation cover increased on the south bank and on the river channel by

the summer of 2013, but purple loosestrife and common reed are just beginning to bloom so the actual extent cannot be observed for this study.

Conclusion

Both invasive species pushed out native wetland plant species from the observed location and created thick monocultures along the south riverbank at Rowe Sanctuary. Purple loosestrife and common reed take up large amounts of water; during the 2012 drought, purple loosestrife was prevalent and fully bloomed, while native plant species died from lack of water. Locations on the river in which sandhill cranes were observed roosting varied due to water depth, tall and thick monocultures of invasive plant species, and weather events. The time-lapse imagery supports the findings of previously conducted research related to common reed, purple loosestrife, and sandhill crane roosting habitat. Purple loosestrife and common reed are continuing to encroach on riverbanks; therefore combined control methods should continue to be conducted throughout the Platte River Basin to decrease their abundance on the central Platte River. The best control method observed is a combination of disking and applying herbicide in the same summer season; a burn-herbicide method at this location would be beneficial because it will increase the plant diversity and decrease the presence of invasive plant species (Rapp, et al., 2012). As plant diversity increases and invasive plants decrease, the relative availability of sandhill crane roosting habitat at Rowe Sanctuary will increase significantly.

Figures



Figure 1. Common reed along the central Platte River. (Harris, 2013)



Figure 2. Purple loosestrife in the summer of 2012, from “Rowe Crane Cam”. (Forsberg, 2012)

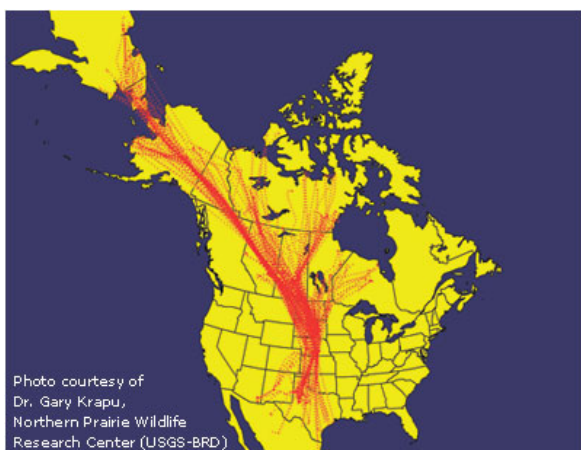


Figure 3. Central Flyway map used by the sandhill crane. (Flyway, 2012)

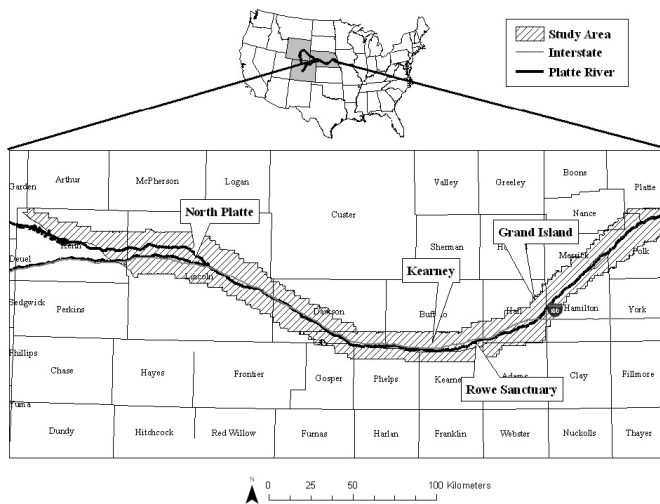


Figure 4. The 80-mile portion of the central Platte River used during spring migration. (Kessler et al, 2011)



Figure 5. Sandhill cranes foraging harvested croplands near Rowe Sanctuary in spring, 2013. (Harris, 2013)



Figure 6. Sandhill cranes foraging, bathing, and resting at Mormon Island prairie wetland.
(Forsberg, 2012)



Figure 7. A night of dense roosting during the 2013 spring migration. (Forsberg, 2013)



Figure 8. Snowstorms and severe weather during spring migration can impact roosting
habitat availability. (Harris, 2013)

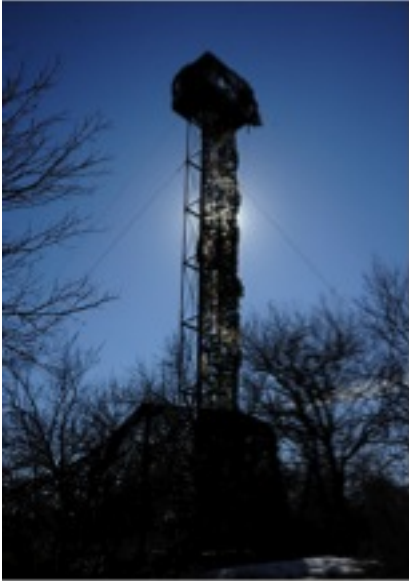


Figure 9. The Rowe Tower time-lapse camera is mounted inside the box at the top of the tower and looks upstream. (Forsberg, 2011)



Figure 10. The “Rowe Crane Cam” is mounted on a wooden pole about 20 feet away from the south riverbank. This pole also holds Rowe Sanctuary’s live feed camera, which captures video footage of the river during spring migration and the camera installed on February 28, 2013. (Arneson, 2013)



Figure 11. The time-lapse camera installed on February 28, 2013 is mounted on a pole located approximately 20 feet away from the south riverbank. (Harris, 2013)



Figure 12. Rowe Sanctuary owned land is outlined in red and the river channel disked in 2004 is highlighted in yellow. (Wingfield)

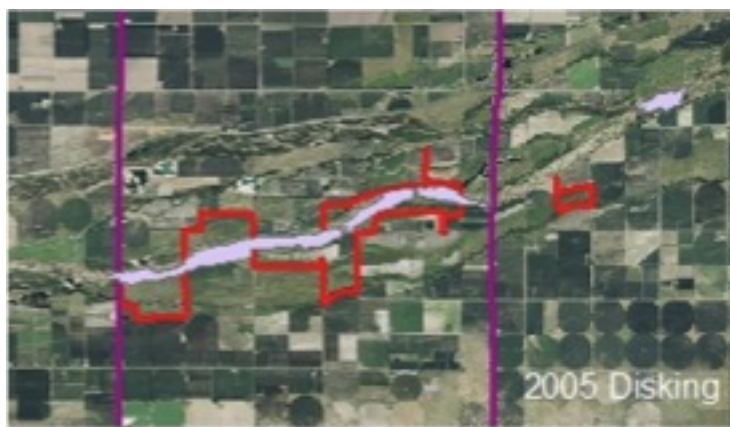


Figure 13. The purple shaded sections of the river channel were disked in 2005. (Wingfield)



Figure 14. The blue shaded segments of the river channel were disked in 2006.

(Wingfield)



Figure 15. The tan colored sections of the river channel were disked in 2007. (Wingfield)



Figure 16. The shaded section of the river channel was disked in 2008. (Wingfield)

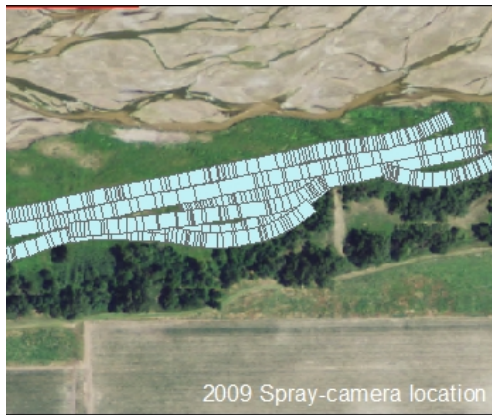


Figure 17. The blue boxes indicate areas that were sprayed for common reed with the herbicide Habitat. Common reed was sprayed with this herbicide on the south riverbank along the section the time-lapse cameras are located in 2009. (Walters)



Figure 18. The blue boxes on the north side of the river, across from the time-lapse cameras, were sprayed for common reed with the herbicide Habitat in 2011. (Walters)



Figure 19. Native grass and forb seeds were dispersed on the small segment on the north bank, across from the time-lapse cameras. (Wingfield)



Figure 20. Spring migration in 2011 from Rowe Tower. (Forsberg, 2011)



Figure 21. Summer 2011 from Rowe Tower. (Forsberg, 2011)



Figure 22. 2012 spring migration from Rowe Tower. (Forsberg, 2012)



Figure 23. A thick stand of purple loosestrife can be seen in the summer of 2012.

(Forsberg, 2012)



Figure 23. Spring migration in 2013 from Rowe Tower. (Forsberg, 2013)



Figure 24. Early July 2013 before purple loosestrife and common reed bloom. (Forsberg, 2013)

References

- Ailstock, S. M., Norman, M. C., Bushmann, P. J. (2011). Common reed *phragmites australis*: Control and effects upon biodiversity in freshwater nontidal wetlands. *Restoration Ecology*, 9(1), 49-49. doi: 10.1046/j.1526-100x.2001.009001049.x
- Blossey, B. (1999). Before, during and after: the need for long-term monitoring in invasive plant species management. *Biodiversity and Conservation*, (1), 301-311.
- Blossey, B., Skinner, L.C., Taylor, J. (2000). Impact and management of purple loosestrife (*Lythrum salicaria*) in north america. *Biodiversity and Conservation*, 10(1), 1787-1807.
- Central Platte River invasive plants: Best management field guide. (2013). Kearney, NE: Platte Valley Weed Management Area; p. 28-31.
- Flyway, N. (2012). The central flyway. Retrieved 11/25, 2012, from <http://www.nebraskaflyway.com/page.php?pgID=2>
- Folk, M. J., Tacha, T. C. (1990). Sandhill crane roost site characteristics in the north platte river valley. *The Journal of Wildlife Management*, 54(3), 480-486.
- Forsberg, M., Archibald, G., Harris, J. (2004). The gathering on the platte. On ancient wings: The sandhill cranes of north America (1), 105-107. Lincoln, NE: Michael Forsberg Photography.

- Kessler, A. C., Merchant, J. W., Allen, C. R., & Shultz, S. D. (2011). Impacts of invasive plants on sandhill crane (*grus canadensis*) roosting habitat. *Invasive Plant Science and Management*, 4(4), 369-377. doi: <http://0-dx.doi.org.library.unl.edu/10.1614/IPSM-D-11-00036.1>
- Krapu, G. L., Facey, D. E., Fritzell, E. K., & Johnson, D. H. (1984). Habitat use by migrant sandhill cranes in nebraska. *The Journal of Wildlife Management*, 48(2), 407-417.
- Krapu, G. L., Reinecke, K. J., & Frith, C. R. (1982). Sandhill cranes and the platte river. *USGS Northern Prairie Wildlife Research Center*, 87, 542-552.
- Rapp, R. E., Datta, A., Irmak, S., Arkebauer, T. J., & Knezevic, S. Z. (2012). Integrated management of common reed (*phragmites australis*) along the platte river in nebraska. *Weed Technology*, 26(2), 326-333. doi: <http://0-dx.doi.org.library.unl.edu/10.1614/WT-D-11-00119.1>
- Audubon Society. (2012). About us, rowe sanctuary. Retrieved 11/24, 2012, from <http://rowe.audubon.org/about-us-17>
- Sparling, D., & Krapu, G. (1994). Communal roosting and foraging behavior of staging sandhill cranes. *The Wilson Bulletin*, 106(1), 62-77.
- Tacha, T. C., Vohs, P. A., & Iverson, G. C. (1984). Migration routes of sandhill cranes from mid-continental north america. *The Journal of Wildlife Management*, 48(3), 1028-1033.